इंटरनेट मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

IS 11182-2 (1984): Guide for the Evaluation of Insulation Systems of Electrical Equipment, Part 2: Thermal Endurance Test Procedures [ETD 2: Solid Electrical Insulating Materials and Insulation Systems]

"ज्ञान से एक नये भारत का निर्माण"
Satyanarayan Gangaram Pitroda
"Invent a New India Using Knowledge"

Act Number 22 of 2005
The Indian Parliament
RIGHT TO INFORMATION

Made Available By
Public.Resource.Org

"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

BLANK PAGE

BRUTUM FULMEN

IGNORANTIA JURIS NON EXCUSAT

PROTECTED BY COPYRIGHT

“पुनःपुष्टि १९९६”
“RE-AFFIRMED 1996”

IS : 11182 (Part 2) - 1984

(Reaffirmed 2001)

Indian Standard

GUIDE FOR THE EVALUATION OF INSULATION SYSTEMS OF ELECTRICAL EQUIPMENT

PART 2 THERMAL ENDURANCE TEST PROCEDURES

UDC 621·31·048 : 620·179·13(026)

© *Copyright* 1985

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 3

August 1985

Indian Standard

GUIDE FOR THE EVALUATION OF INSULATION SYSTEMS OF ELECTRICAL EQUIPMENT

PART 2 THERMAL ENDURANCE TEST PROCEDURES

Electrical Insulation Systems Sectional Committee, ETDC 65

Chairman	*Representing*
DR O. P. CHHABRA	Bharat Heavy Electricals Ltd, Hardwar
Members	
SHRI B. SUDARSHAN SHRI N. V. SATYANARAYANA	(*Alternates* to Dr O. P. Chhabra)
SHRI ASWATHANARAYANA	NGEF Ltd, Bangalore
SHRI MAHADEVA RAO (*Alternate*)	
SHRI S. B. BAPAT	Dr Beck & Co (India) Ltd, Pune
SHRI R. S. LAAD (*Alternate*)	
SHRI S. G. DESHMUKH	Bharat Bijlee Ltd, Thane
SHRI P. N. SALARIA (*Alternate*)	
DIRECTOR	Central Power Research Institute, Bangalore
SHRI B. MAHAJAN (*Alternate*)	
DIRECTOR (HEC & O)	Central Electricity Authority, New Delhi
SHRI P. N. HIRIYANNAIAH	Kirloskar Electric Co Ltd, Bangalore
SHRI G. UMESH (*Alternate*)	
JOINT DIRECTOR STANDARDS ELECTRICAL-2	Research Designs & Standards Organization (Ministry of Railways), Lucknow
ADDITIONAL DIRECTOR ELECTRICAL B-1 (*Alternate*)	
LT-COL S. KEWAL RAMAN	Ministry of Defence (DGI)
SHRI S. K. BATRA (*Alternate*)	
SHRI A. S. LAKSHMANAN	Senapathy Whiteley Ltd, Bangalore
SHRI Y. S. VENKATESWARAN (*Alternate*)	
DR M. S. PADBIDRI	Hindustan Brown Boveri Ltd, Faridabad
DR M. RAMAMOORTY (*Alternate*)	
DR G. M. PHADKE	Indian Electrical Manufacturers' Association, Bombay
SHRI K. S. KAPOOR (*Alternate*)	

(*Continued on page* 2)

© *Copyright* 1985
INDIAN STANDARDS INSTITUTION
This publication is protected under the *Indian Copyright Act* (XIV of 1957) and reproduction in whole or in part by any means except with written permission of the publisher shall be deemed to be an infringement of copyright under the said Act.

(*Continued from page* 1)

Members	*Representing*
PROF V. PRABHASHANKER	Indian Institute of Science, Bangalore
SHRI P. L. PRADHAN	Jyoti Ltd, Vadodara
SHRI B. G. SHARMA (*Alternate*)	
SHRI C. C. SAKARDA	Permali Wallace Ltd, Bhopal
DR L. C. ANAND (*Alternate*)	
SHRI S. P. SACHDEV, Director (Elec tech)	Director General, ISI (*Ex-officio Member*)

Secretary

SHRI K. GANESH
Deputy Director (Elec tech), ISI

Indian Standard

GUIDE FOR THE EVALUATION OF INSULATION SYSTEMS OF ELECTRICAL EQUIPMENT

PART 2 THERMAL ENDURANCE TEST PROCEDURES

0. FOREWORD

0.1 This Indian Standard (Part 2) was adopted by the Indian Standards Institution on 28 November 1984, after the draft finalized by the Electrical Insulation Systems Sectional Committee had been approved by the Electotechnical Division Council.

0.2 This standard consists of several parts. This part (Part 2) is a guide for the development of system test procedures for the thermal evaluation of insulation systems for electrical equipment. It recommends the basic list of test procedures applied to a case where the thermal factor of influence is a dominating ageing factor. Subsequent parts are intended to deal with guidelines on test procedures to evaluate behaviour of insulation systems under different factors of influence.

0.3 These test procedures specify tests which involve accelerated thermal ageing of insulation systems based on conditions of use. The objective of these test procedure is to provide for the functional evaluation, by test, of insulation systems of electrical equipment.

0.4 It is recognized that a given insulation system may be used under different conditions of temperature, time, voltage, etc. Therefore the evaluation of an insulation system involves, according to test procedures developed from this guide, the T factor of influence as described in Part 1 of this standard. The evaluation of insulating materials and simple combinations therefore, is provided for by a separate material test guide namely 'Indian Standard guide for determination of thermal endurance properties of electrical insulating material' (IS : 8504).

0.5 This Indian Standard (Part 2) is completely aligned with IEC Pub 611 (1978) 'Guide for the preparation of test procedures for evaluating the thermal endurance of electrical insulation systems', issued by the International Electrotechnical Commission (IEC).

1. SCOPE

1.1 This standard (Part 2) is a guide for the development of system test procedures and recommends points to be considered in the preparation of specific instructions for the thermal evaluation of insulation systems for electrical equipment.

1.2 It recommends the basic list of test procedures applied to a case where the thermal factor of influence is a dominating ageing factor.

2. TEST PROCEDURES

2.1 The test procedures for the thermal evaluation of insulation systems for electrical equipment shall include descriptive remarks providing a clear understanding of the objectives of the particular tests with respect to the industry served and of the special requirements that exist. The following points shall be ensured in each test procedure prepared for thermal evaluation of insulation system:

a) gives statistically consistent results;

b) provides data free from bias of the tester;

c) results in information that correlates with field experience in a generally acceptable manner; and

d) includes, if models are used, descriptions of these models (the equipment itself may be evaluated where feasible).

3. TEST OBJECTS

3.1 Wherever practicable, the equipment itself should be used for the thermal evaluation of insulation systems. However, when size and convenience require their use, insulation systems may be evaluated by models rather than by full-size equipment. Models should be made to embody the essential elements of the equipment they represent and the process used for making them should be as close as possible to that used for manufacturing the equipment.

A model may include more than one insulation component or test specimen. Test procedures shall specify the minimum number of models and test specimens that are to be tested under each particular ageing condition to obtain reasonable statistical accuracy. The wider the spread in failure times among the specimens exposed at each temperature, the larger is the number of test specimens required to achieve an acceptable degree of confidence. The number of test specimens used at each exposure temperature shall, therefore, be determined by a statistical analysis of the scatter in failure times and by the degree of accuracy desired in the determination of average specimen life.

Preliminary tests shall be included to ensure that models are typical of the systems being tested and are capable of passing the diagnostic tests prior to the ageing.

4. THERMAL AGEING

4.1 Choice and Control of Temperature — Evaluation of tests involve accelerated thermal ageing in the specified ambient with exposures to diagnostic factors, either periodically or continuously. A primary objective of these systems' test procedure is the determination of changes in the essential characteristics of insulation systems under various degrees of thermal ageing, either continuous or cyclic. If cyclic exposure is used, each cycle shall include a temperature exposure period. The thermal ageing is accomplished by continuous or periodic exposure of equipment or models to controlled temperature conditions. The exposure temperatures, conditions and the length of each cycle shall be specified. It is important to select ageing temperature sufficiently high to give useful results in a reasonable time. However, the tests should not be so greatly accelerated that the data need be extrapolated so far on the temperature scale as to lead to an erroneous or inconclusive evaluation of an insulation system. Therefore, it is suggested that any system being evaluated should have not less than three temperatures under study, chosen in an interval so that possible changes of the ageing mechanism may not invalidate the extrapolation. The lowest of these temperatures should not exceed by more than 20°C the temperature to which the results will be extrapolated. The other temperatures should be separated by intervals of 20°C or more. However, 10°C intervals may be suitable, especially where more than three temperatures are studied, or where it is necessary to carry out tests in a limited temperature range. Preliminary testing may be necessary to ascertain that the test range conforms to **8.1** (a).

Insulation systems for equipment in service operate at various temperatures. The test conditions should relate to these various temperatures, especially when the components used in the insulation system have different thermal endurance properties. Over heating provides the most consistent control and recording of temperature exposure, but does not simulate the service conditions. In cases where temperature gradient is important, a different method of heating may be used. This may create problems associated with the generation of heat and with the determination and control of temperatures. Accuracy of temperature control and uniformity of temperature (if an oven is used) are extremely important and should be carefully checked. The test procedure should specify the rate of heating and cooling of the specimen during test, and the method of temperature determination and tolerance limits for the variation of temperature in time and space.

4.2 Influence of Associated Materials and Products of Decomposition — Test procedures should take cognizance of the possible degrading effect of associated materials on insulation systems. Such materials may be part of the insulation system or adjacent parts in its physical support, in the equipment itself, or in the cooling medium. The ventilation used during the ageing of models should not significantly affect the ageing mechanism normally experienced in service. Consideration should be given to the removal or retention of decomposition products.

4.3 Environments — It should be noted that, in many types of equipment, gases or liquids are part of the insulation system and must be considered while developing test procedures.

4.3.1 Where equipment operates under different atmospheric conditions more severe than air (for example, chemical, dust, liquid, gas), the test conditions should simulate the service conditions when relevant. Thus, in these special cases, environmental conditioning may be included in the test procedure. However, it should be noted that the thermal ageing results under two different environmental conditions are not directly comparable.

5. CHOICE OF AGEING MODE—CYCLIC OR CONTINUOUS

5.1 One of the commonly used procedures of thermal ageing is to expose the specimens for a given period of time to the temperature conditions. After exposure to temperature, the specimens are then subjected to diagnostic factors. The temperature-diagnostic factor exposure is referred to as a cycle and is repeated until the end point is reached. However, thermal ageing is sometimes applied continuously, and the diagnostic factors are applied periodically. Table 1 gives an illustrative example of how cyclic procedure may be used.

5.1.1 When cyclic testing is used, there should be a rational relation between length of cycle, exposure temperature and expected operating temperature. It is recommended that the length of the ageing cycle at each exposure temperature be selected to approximate one-tenth of the average specimen life for this test. Values of thermal ageing cycles may be established for specific equipment. The time or temperature may be adjusted to make the best use of test facilities.

6. DIAGNOSTIC FACTORS

6.1 General — When making functional tests of insulation systems, other stresses, such as electrical, mechanical and environmental are frequently used as diagnostic factors to determine end points. For further information on this point, refer Table 1 of Part 1 of this standard particularly non-destructive testing. The equipment Sectional Committee should specify the sequence where necessary.

TABLE 1 ILLUSTRATIVE EXPOSURE TEMPERATURES AND CYCLE DURATIONS

(*Clause* 5.1)

	Anticipated Service Temperature Range (°C)						Temperature Exposure Time per Cycle (Days)
	80 104	105 129	130 154	155 179	180 204	205 229	
Exposure Temperature (°C)	155	180	200	230	255	280	1
	145	170	195	220	245	270	2
	135	160	185	210	235	260	4
	125	150	175	200	225	250	8
	115	140	165	190	215	240	16
	105	130	155	180	205	230	32
	95	120	145	170	195	220	64

Note 1 — This table is considered to be illustrative only and other tables are in use. The appropriate equipment Sectional Committee can choose test ranges, exposure temperatures and length of cycles to be suitable for their particular equipment problems. They may find it convenient, for example, to replace the temperature range by a specific limiting temperature, or to make the time per cycle in weekly multiples, or to adjust the ageing temperature for laboratory convenience.

Note 2 — The end of insulation life is assumed to have occurred at the mid-point of the exposure time between the two consecutive applications of diagnostic factors: the one during which failure was observed, and the last prior application of diagnostic factors with no failures. *See* 7.

6.2 Humidification — Humidification in varying degrees, not causing irreversible charges, can be used as a diagnostic factor to make electric test more discerning of physical and thermal damage to electrical insulation systems (*see* IS : 9000*). The presence of condensed moisture on insulation permits overvoltages to seek out and discern cracks and porosities in insulation, whether such openings are the result of faulty construction, physical damage or thermal ageing.

6.2.1 Humidity, in some cases, is recognized as a major cause of variation in the properties of electrical insulation, and it may cause several different types of insulation failure under electrical stress. The absorption of moisture by solid insulation has a gradual effect of increasing dielectric loss, reducing insulation resistance, and may also contribute to a change in electric strength.

---

*Basic environmental testing procedures for electronic and electrical items (in various parts).

6.2.2 In some cases, it is desirable to use 100 percent relative humidity for periodic moisture exposure. Condensation, its presence or absence, should be specified. In other cases, lesser degrees of humidification may be employed successfully. When a relevant Equipment Sectional Committee selects humidification as a diagnostic factor, time of exposure, temperature, relative humidity and temperature difference between insulation and environment should be specified. If the testing cannot be performed while the specimen is exposed to humidification, specifications should also be made of the maximum time between removal from humidification and testing.

6.3 Mechanical Stress — For equipment usually subjected to vibration, physical shock, thermal cycling or other mechanical stress, the test procedure may include exposure to such conditions as a diagnostic factor. The mechanical stress should be of such magnitude that it is only a diagnostic factor, and therefore does not introduce significant additional ageing. For models, as well as some types of equipment, the most practical way of introducing mechanical stress is by means of vibration, shock or short circuit. The type, severity and duration of the forces should be specified.

NOTE — Mechanical stress is being dealt with as an ageing factor in Part 5 of this standard which is under preparation.

6.4 Electrical Stress — When electrical stress is used as a diagnostic factor, the test voltage is usually selected to be of a level similar to that used in normal acceptance or maintenance testing of the equipment so as to ascertain when any portion of the insulation system has deteriorated to condition such that it is unreliable for continuous service. The voltage test should not be of such duration as to introduce additional ageing.

NOTE — Electrical stress is being dealt with as an ageing factor in Part 3 of this standard which is under preparation.

7. END-POINT CRITERIA

7.1 Each test procedure should be specific in describing the various criteria for the determination of end point. The selected end point should be related to serviceability, the life, at test temperature, of an insulation system specimen is defined as the total test temperature exposure time minus one-half of the exposure time of the cycle during which failure occurred. Normally, the cycles of temperature exposure and application of diagnostic factors are repeated until all the specimens have failed.

8. INTERPRETATION OF THERMAL ENDURANCE DATA

8.1 The method for analyzing and reporting the data should be described in detail in the test procedure.

When insulation systems are tested according to a test procedure, it is important for uniformity that the test procedure specify the following:

a) The temperature range over which the endurance values of insulation systems may be extrapolated. This extrapolation should be limited. When data are used to evaluate thermal endurance under service conditions, it is recommended that extrapolation from the lowest exposure temperature be not greater than 20°C.

b) The mathematical treatment of data, including expressions of confidence limits.

c) The additional limitations regarding extrapolation and spread of data, if the thermal endurance curve is non-liner, even after mathematical transformation based on chemical or physical considerations (for example, arrhenius relationship).

d) The values of time or temperature to be taken from the thermal endurance curve to be used for the comparison of insulation systems.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 kg. m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2